Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Aeronet Global Communications Inc.'s Petition for Rulemaking to Amend the Commission's Allocation and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands to Authorize Maritime Scheduled Dynamic Datalinks	))))))))))	RM-________________________

PETITION FOR RULEMAKING OF AERONET GLOBAL COMMUNICATIONS INC.

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Pursuant to Section 1.401 of the Commission's rules,[1] Aeronet Global Communications Inc. hereby petitions the Federal Communications Commission to initiate a rulemaking to amend its allocation and service rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz spectrum bands (collectively the "E-Band" or the "Band") to authorize the use of maritime scheduled dynamic datalinks ("SDDLs") as described herein.[2]

INTRODUCTION AND EXECUTIVE SUMMARY

With this Petition, Aeronet requests that the Commission adopt minor amendments to its allocation and service rules for the E-Band to authorize Aeronet's planned use of this spectrum to provide high-speed (Gigabit per second or "Gbps") broadband to cruises, ferries, and other ships at sea. Aeronet's planned service will unlock the "Internet of the Sea," delivering substantial public interest benefits to consumers, shiplines, crew, and public safety.

[1] 47 C.F.R. § 1.401.

[2] In a companion Petition for rulemaking, Aeronet is seeking similar amendments to authorize the use of aviation scheduled dynamic datalinks in the E-Band.

As the Commission is aware, demand for at-sea broadband is outstripping what shiplines currently can provide. New satellite technologies and networks have made at-sea Wi-Fi more commonplace, but connections remain unstable, speeds remain inconsistent, prices remain high, and there simply is not adequate capacity to support the increasing bandwidth demands on each cruise or ferry—let alone the combined data demands of multiple ships in the same area.

Aeronet will bring new competition into the maritime market through the introduction of a new connectivity technology, capable of handling the significant demand for high-speed broadband on each equipped ship. Consumers will be able to access their own HD content, online and streaming applications, and data services, at terrestrial equivalent speeds and latency, as they travel. This includes recreational passengers, who carry data-intensive devices everywhere they go, and professionals, who will be able to use the faster and more stable connectivity to monitor projects while at sea. Moreover, shiplines will be able to install and operate new Internet of Things ("IoT") equipment and facilities like weather monitors and engine sensors, achieving significant operational efficiencies, savings, and other benefits.

Aeronet's SDDLs are an innovative application of a technology that certain industries and the military have long used to transmit large volumes of data over long distances by establishing point-to-point networks with narrow-beam spectrum. Aeronet has demonstrated through live trials the ability to establish, configure, and maintain SDDLs to deliver 1-3 Gbps download and upload service, continuously, to a cruise ship as it sails along its route, and 1 Gbps speeds to an aircraft along its test flight route. Moreover, Aeronet is engaged in live customer market testing of the maritime application of its SDDLs off Florida, and it is engaged in ongoing internal testing to demonstrate the ability to create sub-mesh networks from ground station to ship, ground station to relay (as described below) to ship, and from ship to ship.

The spectrum in the E-Band is uniquely suitable for this technology, given its high frequency and high antenna directionality, as well as the large bandwidth that is available. Additionally, the historical light-touch framework governing the E-Band both here and abroad makes this spectrum ideal for coordinating with scheduled known vehicles in motion like cruises, ferries, and other ships at sea. Given the spatial separation of various uses in the E-Band, Aeronet's SDDLs are unlikely to cause interference with other users—even as E-Band spectrum is adopted more widely for wireless backhaul to support 5G applications in dense urban settings. That is why Aeronet has actively participated in the Commission's *Spectrum Frontiers* proceeding and other dockets to support innovative uses of this spectrum. Our priority, like the Commission's, is ensuring that the E-Band rules are flexible and conducive to the development of multiple new technologies.

While Aeronet's use of SDDLs involves point-to-point datalink communication between network endpoints that are in motion, Commission precedent supports treating the service as "fixed," given the limited and predictable patterns of the movement (*i.e.*, along a ship's route) at issue. Over the last 15 years and especially recently, the Commission has taken such an approach, enthusiastically and on a bipartisan basis, authorizing mobile satellite communications in larger amounts of spectrum that is specifically designated for Fixed-Satellite Service ("FSS"), to unleash the benefits that accrue from supporting broadband connectivity to vessels in motion. The same logic applies equally here: Existing regulatory classifications in the E-Band allocation and service rules are impeding Aeronet's deployment of an innovative technology that is functionally and operationally consistent with the Commission's broader framework for the E-Band and the Commission's pro-deployment objectives.

To be clear, Aeronet supports the existing framework for the E-Band and is not requesting changes to the structure of the rules or the process for handling link registration and interference disputes. Instead, Aeronet is requesting a few targeted changes that will allow for limited, predictable, and non-interfering communications between scheduled moving points in the E-Band.[3] Aeronet urges the Commission to move quickly to adopt these amendments. Indeed, in light of the benefits of SDDLs and the growing demand for broadband at sea, Aeronet expects that regulators in other countries will authorize a variation of this technology in the near future. Aeronet hopes it is the United States, acting through the Commission, that shows leadership in being the first to authorize this exciting new technology, matching its commitment to win the global race to 5G to the benefit of all Americans.[4]

I. Aeronet Is Capable of Enabling Numerous Public Interest Benefits for Consumers, Shiplines, and Others by Delivering Gbps Broadband to Commercial Cruises, Ferries, and Other Ships at Sea.

Aeronet is a communications services company that has developed an innovative technology to provide Gbps broadband service, on a wholesale basis, to aircraft and maritime vessels. The maritime market is currently under-served by broadband providers, depriving passengers, shiplines, crew, and public safety officials of the numerous benefits that true broadband connectivity would enable.[5] Aeronet has made significant progress by demonstrating

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[3] *See infra* Part III.

[4] *See, e.g.*, *In re Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*, Declaratory Ruling and Third Report and Order, WT Docket Nos. 17-79, 17-84, FCC 18-133 ¶ 1 (rel. Sept. 27, 2018).

[5] *See* Eva Grey, *The Race for Faster WiFi on Board Cruise Ships*, Ship Technology (May 15, 2018), https://www.ship-technology.com/features/race-faster-wifi-board-cruise-ships/ ("On-board connectivity has been notoriously difficult until now. At sea, the Internet is provided mainly by way of satellites, and coverage so far has been patchy, slow, expensive, and . . . mainly a luxury associated with premium packages."); *see also In re Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with*

that Gbps service at sea is not merely conceptual or conjectural; it is already feasible and inevitable, and the Commission should act quickly to ensure that the United States is the global leader in this exciting new broadband market.

A. Without a New Technology Pathway, Broadband Connectivity at Sea Will Not Keep Pace with Demand, Depriving Consumers, Shiplines, Crew, and Public Safety Officials of Innovative Applications.

Consumers want and increasingly expect an "in home" equivalent broadband experience wherever they are. Fueled by near-ubiquitous and ever-faster mobile coverage on the shore, consumers are now demanding faster and more stable connectivity at sea as well.[6] This trend will continue. Consumer online behavior is increasingly data-intensive, involving video streaming, audio streaming, gaming, and video-based social networking.[7] And consumers increasingly will demand access to their own cloud-stored HD or 4K entertainment content, online gaming applications, health and fitness live data, and real-time destination services on any vacation, to any location, with at-home-like performance characteristics, while in transit. Additionally, the ongoing

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Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed Satellite Service, Report and Order and Further Notice of Proposed Rulemaking, IB Docket No. 17-95, FCC 18-138, at 77 (rel. Sept. 27, 2018) ("*ESIM Order*") (Statement of Chairman Ajit Pai) (noting important benefits from "spark[ing] innovation and investment, encourag[ing] deployment, and . . . connect[ing] more consumers" in the "fast-growing segment" of the market for connecting "ships, vehicles, and aircraft"); *id.* at 80 (Statement of Commissioner Jessica Rosenworcel) (commending Commission action that will "expand the reach of [broadband] networks to some of the most challenging environments—our planes, ships, and vehicles").

[6] *See, e.g.*, Grey, *supra* note 5. ("[C]ustomers now expect a reliable WiFi connection while on board, at an affordable price—or even for free.").

[7] Sandvine, *The Global Internet Phenomena Report* 4-5 (Oct. 2018), https://www.sandvine.com/hubfs/downloads/phenomena/2018-phenomena-report.pdf (describing, for example, that video is almost 58 percent of the total downstream volume of traffic on the internet despite aggressive management by operators; that gaming is becoming a significant force in traffic volume as games are designed for ubiquitous connectivity; and that live event streaming is beginning); *id.* at 6-7 (ranking global online applications by traffic share); *id.* at 9 (providing analysis of downstream video traffic share even given optimization techniques).

development of virtual and augmented reality applications and services will dramatically increase consumer upload and download capacity demands. Likewise, executives and professionals will expect (and be expected) to manage projects and cloud server business processes from cruise and ferry decks. Moreover, delivering broadband at a performance level that meets consumers' expectations would unlock further demand among the nearly 12 million U.S. cruise[8] passengers and billions of global ferry[9] passengers—many of whom are not currently connecting to Wi-Fi. Thus, delivering true broadband at sea has the promise to deliver substantial public interest benefits.

But consumers would not be the sole beneficiaries of Gigabit-speed broadband service at sea. As demand for cruise trips has recently increased, the demographics of cruise passengers are also changing; cruise vacations are gaining traction among millennials who are especially sensitive to broadband capability.[10] Indeed, the Cruise Line Industry Association ("CLIA") has identified as the number one industry trend for 2019 that "Instagram photos are driving interest in travel around the world," noting that "[w]ith onboard connectivity, cruise passengers" are able to fill social media feeds and attract new customers to major cruise destinations.[11] Nevertheless, the

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[8] *See, e.g.*, Florida-Caribbean Cruise Ass'n, *2018 Cruise Industry Overview*, https://www.f-cca.com/downloads/2018-Cruise-Industry-Overview-and-Statistics.pdf; Statista, the Statistics Portal, *Number of Cruise Passengers Carried Worldwide from 2007 to 2019 (in millions)*, https://www.statista.com/statistics/270605/cruise-passengers-worldwide/ (last visited Feb. 4, 2019).

[9] *See* InterFerry, *Ferry Industry Facts*, http://www.interferry.com/communications/ferry-industry-facts/? (last visited Feb. 4, 2019).

[10] *See* Grey, *supra* note 5.

[11] Cruise Lines International Ass'n, *2019 Cruise Trends & Industry Outlook* 6, https://cruising.org/news-and-research/-/media/CLIA/Research/CLIA%202019%20State%20of%20the%20Industry.pdf. Notably, the fourth industry trend is the deployment of on-board smart tech, *id.* at 9, and the ninth industry trend is "working nomads,"—travelers who combine work and leisure time by working remotely using "WiFi, desks[,] and work-friendly cafes" on cruise vacations, *id.* at 14.

average broadband speed for cruise ships is currently 10 to 20 Mbps per ship, and it is rarely, if ever, free.[12] The ability to deliver reliable Gbps service would allow cruise lines to compete more vigorously, not just with each other, but also intermodally with other destination and travel experiences, including destination and resort hotels, where high-speed, free broadband service has become commonplace.[13] Crew, likewise, would benefit, as connectivity would enable them to remain in contact with family and friends during months-long voyages and to enjoy better content and services during extended break periods between service windows.[14] Ferries, too, would become more attractive to commuters and other travelers with high-speed broadband, as passengers would be able to stay connected with family, work, and friends while in transit.

Moreover, Aeronet's maritime SDDLs have the potential to support numerous beneficial applications for the industrial maritime industry. According to one recent report, leaders in this industry have begun to recognize that connectivity will support evolution: "Instead of being limited to ferrying goods from one location to another, [IoT] technology is enabling operators to

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[12] *See* Grey, *supra* note 5; Simon Maher, *New Satellite Technology Transforms Cruise Ship WiFi*, The Maritime Executive (Mar. 5, 2018), https://www.maritime-executive.com/editorials/new-satellite-technology-helps-overhaul-cruise-ship-wifi ("For many years satellite connectivity from cruise ships was powered by single high-orbit satellites that delivered an under-developed, fragmented and unreliable service . . . .").

[13] *See* Maher, *supra* note 12 ("The cruise industry has always competed for guests against luxury on-shore destinations. Previously, poor Wi-Fi connectivity has created a clear distinction between vessels and luxury resorts, with customers that viewed high-speed internet access as a key priority limited to shore based destinations only. For cruise, boosting connectivity now runs in parallel to the continued growth of the industry.").

[14] *See, e.g.*, Talia Lakritz, *What It's Really Like to Live and Work on a Cruise Ship for 7 Months*, Travel Insider (Mar. 12, 2018), https://www.thisisinsider.com/what-working-on-a-cruise-ship-is-like-2016-11; Rebecca Gibson, *Prioritising Crew Welfare Onboard Passenger Ships*, CruiseandFerry.net (Oct. 14, 2016), http://www.cruiseandferry.net/articles/prioritising-crew-welfare-onboard-passenger-ships (recommending that retention will benefit from offering crew members "regular access to free wifi," among other things).

become global logistics experts and pioneers in emerging fields."[15] "The most obvious benefit of IoT connectivity lies in how it can transform day-to-day operations at sea, at port and as part of a wider logistics network. Issues can be pinpointed, downtime can be reduced, and processes can be streamlined, changing the face of the maritime industry as we know it."[16] For example, one shipping company expects to save over $200 million each year in inspection costs with the "simple addition of a modem, a wireless SIM card and a satellite link," which will allow the company to locate and monitor the operational details of over 270,000 refrigerated shipping containers anywhere in the world.[17] Other companies expect IoT applications to help with reducing emissions through engine and shipboard sensors, and improving health and safety through weather sensing and alerts, CCTV monitoring, and drone-based inspections.[18] Aeronet's service would introduce new competition into this market, which is currently dominated by satellite providers.

Aeronet's solution for providing this service—establishing sub-mesh SDDL networks, as described at greater length below—would also enhance shipline security and safety. Security is built into the design of Aeronet's architecture: The network is based on point-to-point datalinks that establish specific and individual connections. Because the links are scheduled and dynamic, every network node will have pre-known locations and schedules, allowing for verification against expected behaviors.[19] It also would be very difficult to intercept a datalink signal, because the

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[15] *See* Malek Murison, *The Maritime IoT Landscape in the Next Decade* (Aug. 6, 2018), https://www.marinemec.com/news/view,the-maritime-iot-landscape-in-the-next-decade_53814.htm.

[16] *Id.*

[17] *Id.*

[18] *See* Inmarsat, *Industrial IoT on Land and at Sea* 27-33 (2018), https://safety4sea.com/wp-content/uploads/2018/09/Inmarsat-IoT-on-land-and-at-sea-2018_09.pdf.

[19] As discussed at greater length below, *infra* at 13, Aeronet has no plans to deliver service to ships that travel outside of authorized areas of operation per frequency coordination processes.

beam will be narrow, moving along the ship's nautical route. Additionally, SDDL facilities will be hardcoded to each specific network node (*e.g.*, to the receiving antenna on an individual ship). This feature will allow authentication prior to establishing connectivity. The facilities are also self-contained; there is no need to connect them to the ship core functions. If, however, a shipline chooses voluntarily to send IoT data from a ship's system via an SDDL, common security features could be installed to maintain the physical layer separation. Aeronet's management and command and control operations would also allow for real-time control of all communications and provide additional layers of preventative security.

Unfortunately, as demand for at-sea broadband grows, so too will the difficulty of providing it. The myriad consumer, shipline, and third-party applications discussed above will create huge bandwidth demands that are equivalent to demands at large corporate campuses,[20] which terrestrially would be directly serviced by a fiber or dedicated cell site capacity. In the maritime market, however, that demand is localized to individual vehicles with their own data needs, operating in dynamic patterns away from traditional terrestrial infrastructures.

Current technologies are simply not designed to deliver optimal backhaul capacity to each ship in such environments. For its part, the mobile industry is preparing to address similar bottlenecks that will arise from the deployment of 5G, which will increase the backhaul demands

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[20] For example, Apple Inc.'s second largest office is currently in Austin, Texas and employs 6,000 people. *See* Aishwarya Venugopal, *Update 6 - Apple Plans New $1 Billion Campus for Austin, Texas*, CNBC (Reuters Dec. 13, 2018), https://www.cnbc.com/2018/12/13/reuters-america-update-6-apple-plans-new-1-bln-campus-for-austin-texas.html. As of 2015, the average cruise ship passenger capacity was approximately 3,000 guests (for ocean liners), *see* Chavdar Chanev, *Cruise Ship Passenger Capacity*, CruiseMapper (Nov. 26, 2015), https://www.cruisemapper.com/wiki/761-cruise-ship-passenger-capacity-ratings, and the largest cruise ships have the capacity to host more than 5,000 passengers along with additional crew. *See, e.g.*, Cruise Industry News, *Cruise Industry Trends for 2019* (Jan. 2, 2019), https://www.cruiseindustrynews.com/cruise-news/20124-cruise-industry-trends-for-2019.html.

for mobile data from urban, suburban, and rural sites alike.[21] Ericsson projects that certain urban sites already need 1 Gbps backhaul to satisfy consumer demand, with this requirement growing to 10 Gbps by 2022. As consumers' data demands on cruise ships and ferries increasingly resemble their demands on the ground, each vessel will need similar backhaul capabilities. No single network or platform—not even Aeronet's—can satisfy the total demands of the maritime market. Thus, absent action by the Commission to make such connectivity possible, at-sea broadband throughout the United States will continue to lag behind other fixed and mobile broadband services.[22]

B. Aeronet Has Demonstrated That Delivering True Broadband Connectivity at Sea Is Possible Through Establishing SDDL Networks Using Spectrum in the E-Band.

Aeronet's solution unlocks the Internet of the Sea by delivering Gbps service via dedicated, high-capacity, low-latency, line-of-sight SDDLs. There is a long history in the information and communications technology industries of using point-to-point datalinks to handle heavy data volumes in a variety of contexts, for example wireless network backhaul.[23] Aeronet has adapted

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[21] *See* Ericcson, *Microwave Outlook* (Dec. 2018), https://www.ericsson.com/assets/local/microwave-outlook/documents/ericsson-microwave-outlook-report-2018.pdf.

[22] As discussed below, if the Commission does exercise leadership in this area, other jurisdictions that also have adopted light-touch regulation in the E-Band may follow suit, creating opportunities for further international harmonization. *See infra* note 54.

[23] *See* David Abecassis, Janette Stewart, & Alex Reichl, Analysys Mason, *Review of Spectrum Management Approaches for E-Band (70/80 GHz) in Selected Markets* 10 (2016), https://www.telecomnews.co.il/image/users/228328/ftp/my_files/General%20Files/Report_Spectrum_Management_E-Band_AnalysysMason2016.pdf?id=27306642 ("Fixed-wireless links or fixed links provide line-of-sight transmissions between two geographical locations. Fixed links are used extensively for point-to-point telecoms, as well as for point-to-multipoint telecoms to convey voice and data signals. One of their major uses is for backhaul within mobile networks (*i.e.* to connect wireless base stations with the mobile network backbone). Other uses include voice and data communications directly to end users as a replacement for copper or cable communications (*e.g.* the 'last-mile' connection) and point-to-point links with the communications networks used by various enterprises, local governments and other businesses."); *In re Business*

this architecture to meet the challenges of delivering at-sea broadband, and has demonstrated in live trials that Gbps download and upload broadband service is possible using its technology.[24] Aeronet's business model is consistent with multiple geographic deployments, and interest in unlocking this solution has already allowed Aeronet to actively discuss partnerships with tier-1 providers in the Caribbean. But full-scale commercialization of this innovative service in the United States will require action by the Commission.

1. Aeronet's SDDL Networks Enable the Delivery of Dedicated Backhaul Connectivity to and from Cruises, Ferries, and Other Ships.

Aeronet has developed a datalink technology (*i.e.*, SDDLs) that allows it to create, reconfigure, and maintain, in real time, multiple networks involving a variety of point-to-point links between nodes—including ground stations, relay nodes,[25] cruises, ferries, and other ships capable of carrying the datalink equipment—for data traffic.

Aeronet's ground stations will serve as the terrestrial entry point for backhaul and as the high-capacity core backbone layer of the Aeronet network. Ground stations will be connected by direct fiber circuits, for which capacity can be managed to suit the aggregated demand based on standard telecommunications network management practices. Each ground station will be

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Data Services in an Internet Protocol Environment, Tariff Investigation Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 4723, 4753 ¶ 68 (2016) ("In the mobile wireless sector, carriers have historically relied on fixed wireless, *i.e.*, often self-provisioned microwave point-to-point links, to backhaul aggregated traffic from their macro cell sites.").

[24] The air force has incorporated similar technology into certain aircraft. *See* Henry Kenyon, *Programmable System Guides Jet to New Heights*, Signal (June 2008), https://www.afcea.org/content/programmable-system-guides-jet-new-heights (noting that point-to-point narrow-beam datalinks allow aircraft to share data with each other with limited risk of interception of communications).

[25] Relay nodes are aerostats or drones, at fixed locations below 1,000 feet, either tethered or untethered, to allow SDDLs beyond the horizon.

designed to establish multiple narrow-beam datalinks, capable of being steered across some or all of the sea within sight.

Using dedicated and professional installation teams, Aeronet will install SDDL facilities on customer ships. Up to two SDDL antenna facilities will be installed per ship providing sufficient option for a ship-to-ground datalink for connection to a ground station or a ship-to-ship datalink for connection to other ships or ship-to-relay datalink. The combination of these SDDL facilities will provide sufficient look angles to allow line of sight to other nodes within the network and beyond the horizon.

Aeronet will pre-plan individual network nodes and SDDLs into sub-mesh networks, using historical path data from Aeronet's own network operation, general knowledge of ships' known routes, and the spatial areas of registered E-Band links. Each sub-mesh network will be under the control of its own ground station, based on a ship's proximity to the ground station or local conditions, for planned periods of each voyage.[26]

After registering each node onto its sub-mesh network, the ground station will coordinate the real-time formation of SDDLs to ships within its control to ensure no self-interference and within the authorized maritime SDDL parameters. The area of ship-to-ground SDDLs will be defined by two-dimensional polygons from the fixed location ground station to a subset of the ships assigned to it and limited to the heights of the fixed location (or ship if higher). The area of ship-to-ship SDDLs also will be defined by two-dimensional polygons based on ship routes and ship heights. The area of ground-to-relay-to-ship SDDLs will be defined by a direct link from the fixed location ground station to the relay node (which, as noted, will be at a fixed point, under

[26] As necessary, Aeronet's command and control center could also disconnect a node from a pre-planned network in real time.

1,000 feet of elevation), and then three-dimensional polyhedrons from the relay node to the ships assigned to it.

If a ship were to deviate from a known route in a way that takes it outside of a registered SDDL, the ground station would recognize the deviation in real time, based on command channel telemetry. Connectivity would discontinue until the ship returned into the registered network along its planned route.

By forming and occasionally reconfiguring SDDLs and sub-mesh network assignments, Aeronet can keep ships connected, supporting standard IP data traffic at sea and outside of ground-station coverage.[27] Figure 1 illustrates how SDDLs can support ground-to-ship, ground-to-relay-to-ship and ship-to-ship SDDLs to form the overall network. The SDDLs would operate akin to terrestrial 5G point-to-point backhaul networks.

Figure 1: Depiction of Aeronet's SDDL Networks

By delivering point-to-point bandwidth to each ship, Aeronet avoids having to share spectrum between multiple vessels in congested locations, which sharing has been a limitation for

[27] Aeronet's model is easily scalable as demand grows (and as more ship join the network) with the support of further ground-station datalinks.

other network access layer architectures. Further, Aeronet's ability to reconfigure sub-mesh SDDL networks in real time enables the dynamic selection of the best quality backhaul links to ground stations. Under routine conditions, this will allow Aeronet to deliver service with reduced latency to ground stations, as data is sent via the shortest routes possible. And under other circumstances, this functionality will allow Aeronet to support connectivity by avoiding disruptions associated with storms and other local conditions. Moreover, Aeronet's network management exploits the known and scheduled movement patterns of ships add an additional security control for nodes seeking to access the network and to monitor the behavior of nodes within the network.

This technology is not merely conjectural. In March 2017, Aeronet successfully achieved continuous 1 Gbps download and upload speeds in its test aircraft in Ireland. The objective of this alpha test was to test the proprietary discovery and tracking techniques for the ground station to establish and maintain the air-to-ground SDDL at this frequency band. In 2018 Aeronet specifically focused on maritime applications and environments, achieving similar and higher speed results during beta testing of its SDDLs off the coast of Florida. In these beta tests, Aeronet achieved 3 Gbps speeds and successfully switched between two SDDLs with near unnoticeable service interruption during handover. Aeronet has since installed further test ground stations in the Bahamas for expanded live environment service testing across multiple network nodes. These efforts have involved a substantial investment to date, resulting in technological achievements that evidence Aeronet's ability to deliver the equivalent of fiber-to-the-home performance for at-sea connectivity. And notably, over the nine-month course of Aeronet's testing under its Special Temporary Authorization, Aeronet did not encounter any interference issues or concerns.

In short, Aeronet's maritime application is ready for commercialization. Aeronet has committed, "second-generation" technology plans to expand its tests to cover additional maritime use cases. These plans include even more investment in the United States and regions that attract significant American consumer spend (*e.g.*, the Caribbean). An environment of regulatory certainty for its use of spectrum is an important aspect of maintaining Aeronet's investment and spend focus on the United States.

2. Aeronet Has the Vision and Credentials to Disrupt the Maritime Market Through Expanded Operations in the E-Band.

Given the growing demand for at-sea broadband and its currently constrained supply, there is significant interest throughout the maritime market for new connectivity technologies. Aeronet's wholesale business model allows it to package service to support both customer-facing connectivity as well as crew welfare and shipline operational capabilities. Aeronet is an attractive partner for both major shiplines themselves and for other entertainment service partners. Aeronet is actively exploring partnerships with other technology companies and maritime carriers to support the commercialization of this service.

Indeed, Aeronet already has secured a deployment partner for its initial focus on cruise ships and ferries in the Caribbean region. This is a critical first market because of its heavy cruise ship traffic (especially from the United States).[28] Aeronet has negotiated an agreement with an infrastructure partner who provides IT and telecommunications services to over 40 countries in the Caribbean.[29] The resulting commitment of assets will allow Aeronet to utilize existing fiber

[28] *See supra* note 8. The Cruise industry reports that a plurality—34 percent—of cruise ships are deployed in the Caribbean and that almost 12 million of the global 30 million cruise passengers come from the United States. *See* CLIA, *supra* note 11, at 21, 25.

[29] Indeed, Aeronet's partner is an established provider with direct evidence of the market demand for high-speed connectivity in the Caribbean.

infrastructure, cell site infrastructure, and local market presence, thereby avoiding the delays and costs associated with the network build-out. Aeronet thus will be able to launch its services more quickly, and at lower cost, to cruise lines and ferries operating in the Caribbean. Aeronet is actively exploring partnerships in other regions to support the commercialization of this service from other ports and in other areas with proven demand. For example, working with other infrastructure partners, Aeronet hopes to complete similar deployment planning exercises for regions like the Seattle–Alaska route and the Mediterranean.

Aeronet's service is likely to be highly attractive to other stakeholders and in other markets as well. For example, given the security and control features that are inherent in Aeronet's network architecture, ship owners are likely to view our service as beneficial. And looking beyond aviation and maritime applications, Aeronet anticipates that its SDDLs could have future applications in other un- and underserved environments. For example, this technology could support the delivery of broadband to remote areas, such as rural America, offshore windfarms, and other infrastructure. It also has promising applications in disaster recovery situations, where existing broadband networks may be compromised, but connectivity remains essential. Each such application would deliver public interest benefits.

Moreover, Aeronet is ready to compete with the other providers, including satellite-based providers, who are developing broadband solutions with potential at-sea applications. SDDLs will offer a unique value proposition to shiplines and third-party service providers. That is so because, among other things, the SDDL technology is based on a cost-effective operating model that does not depend on already having or building expensive satellite network assets. By providing a dedicated datalink to each ship, Aeronet also can combine Gbps download and upload speeds with 5G-like latency, while avoiding the complications of shared coverage in congested areas. And, as discussed at greater length below, Aeronet's SDDLs are unlikely to present interference concerns with other users in the E-Band, including potential satellite-based competitors. Consistent with its mandate, the Commission should encourage the nascent competition among broadband providers in the maritime market.

Aeronet is poised to move quickly once this Petition is granted. Committed plans are already in advanced stages of equipment integration for further ground-to-relay-to-ship live trial testing for beyond horizon SDDLs. Aeronet also has worked collaboratively with other regulators—including ComReg in Ireland and, through an affiliate, the Utilities Regulation & Competition Authority in the Bahamas—to obtain necessary authorizations and licenses for its testing. Given the growing demand for at-sea broadband, Aeronet anticipates that other countries will take the initiative to authorize the use of E-Band spectrum to provide a variation of this service.[30] But Aeronet hopes that, with its long history of global leadership on connectivity issues, the United States will seize this opportunity and act quickly to authorize Aeronet's use of maritime SDDLs in the E-Band.

II. The E-Band Is Uniquely Suitable for Aeronet's Technology and Service Offering.

The E-Band is uniquely suitable for Aeronet's SDDLs—for technical, regulatory, and practical reasons. The spectrum is technically ideal for these purposes, because it supports narrow and dedicated beams that are perfect for establishing high bandwidth interference-free networks. Authorizing maritime SDDLs in the E-Band also would be consistent with the Commission's regulatory goals, including commercialization of millimeter wave and higher-frequency spectrum bands, while also encouraging international harmonization of the regulatory framework for the E-

[30] As noted below, many countries follow a light license regime to the E-Band and thus could authorize a similar application with similarly streamlined rule changes. *See infra* note 52.

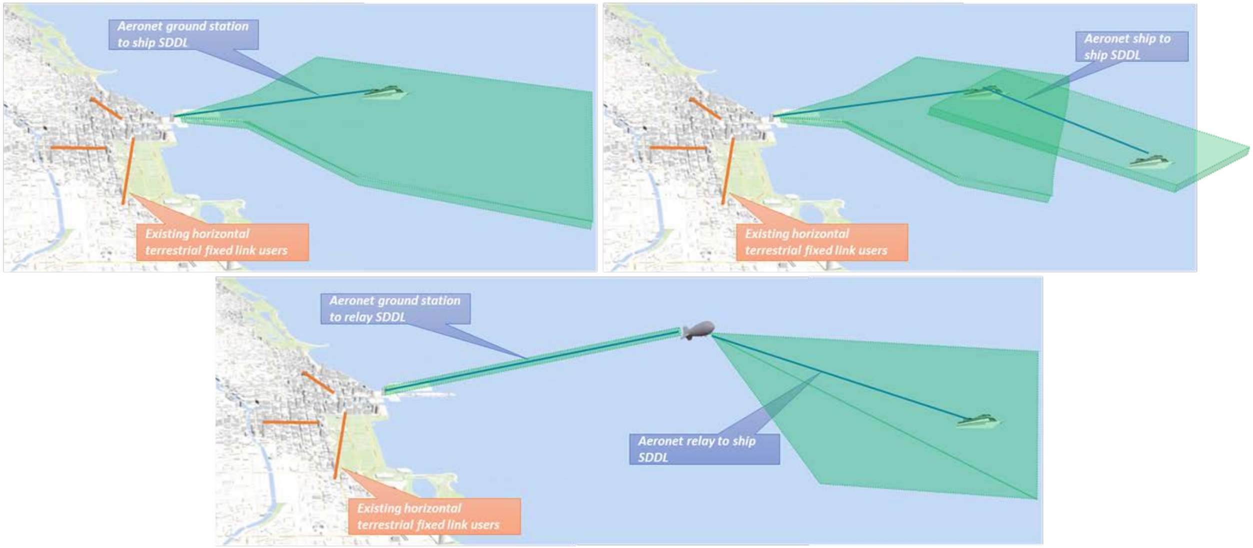
Band. And the E-Band is largely uncongested, meaning there is ample spectrum to support multiple innovative uses, including Aeronet's.

A. The Technical Characteristics of Spectrum in the E-Band Are Ideal for Use in Maritime SDDL Networks with Minimal (if Any) Interference Risks.

The technical characteristics of spectrum in the E-Band are ideal for sub-mesh SDDL networks involving aerostats, drones, and ships. The narrow beam widths in the E-Band support angular separation mechanisms, preventing interference amongst Aeronet's SDDLs, and between Aeronet's use and other uses including terrestrial backhaul.[31] For ease of coordination, Aeronet's links can be organized within separated two-dimensional polygon and three-dimensional polyhedron networks. As depicted below in Figure 2, Aeronet will establish ground-to-ship links, ground-to-relay-to-ship links, and ship-to-ship links based on the known routes of scheduled cruise or ferry voyages, avoiding interference with existing horizontal fixed link users. Critically, these polygons and polyhedrons are not intended to represent exclusive use areas; Aeronet anticipates that, just as two fixed terrestrial links can be coordinated to cross without interference today (except where highly aligned), links for current and future services will be able to pass through Aeronet's networks in most instances following routine coordination procedures.

[31] *See* Abecassis, Stewart, and Reichl, *supra* note 23, at 1 ("[T]he short wavelength of frequencies in the millimetre portion of the radio spectrum, where E-band sits, means that the potential for interference between neighbouring links is reduced, compared to the lower-frequency bands. This implies that regulators have much more scope to implement simplified coordination mechanisms for the licensing of links in E-band . . . .").

Figure 2: Depiction of 3D Polygon and Cone Links Avoiding Interference with Fixed Terrestrial Users



This use case presents minimal, if any, interference concerns for current terrestrial fixed link users.

First, the 12.9 GHz of spectrum in the E-Band is largely uncongested, because incumbent fixed-link user volume remains relatively low. Indeed, in 2016, after a review of operations in the Band, the Commission described that it was "relatively lightly used both in terms of the number of registered sites (especially on a large geographic scale) and with respect to the quantity of spectrum available."[32] Moreover, the Commission continued, "the great majority of existing links in the [B]and[] are concentrated in just a few localities."[33] The Commission thus concluded that, based on the "narrow beam[] widths and limited path legends involved, it would be reasonable to treat" the E-Band as being "the functional equivalent of a green field" throughout the majority of

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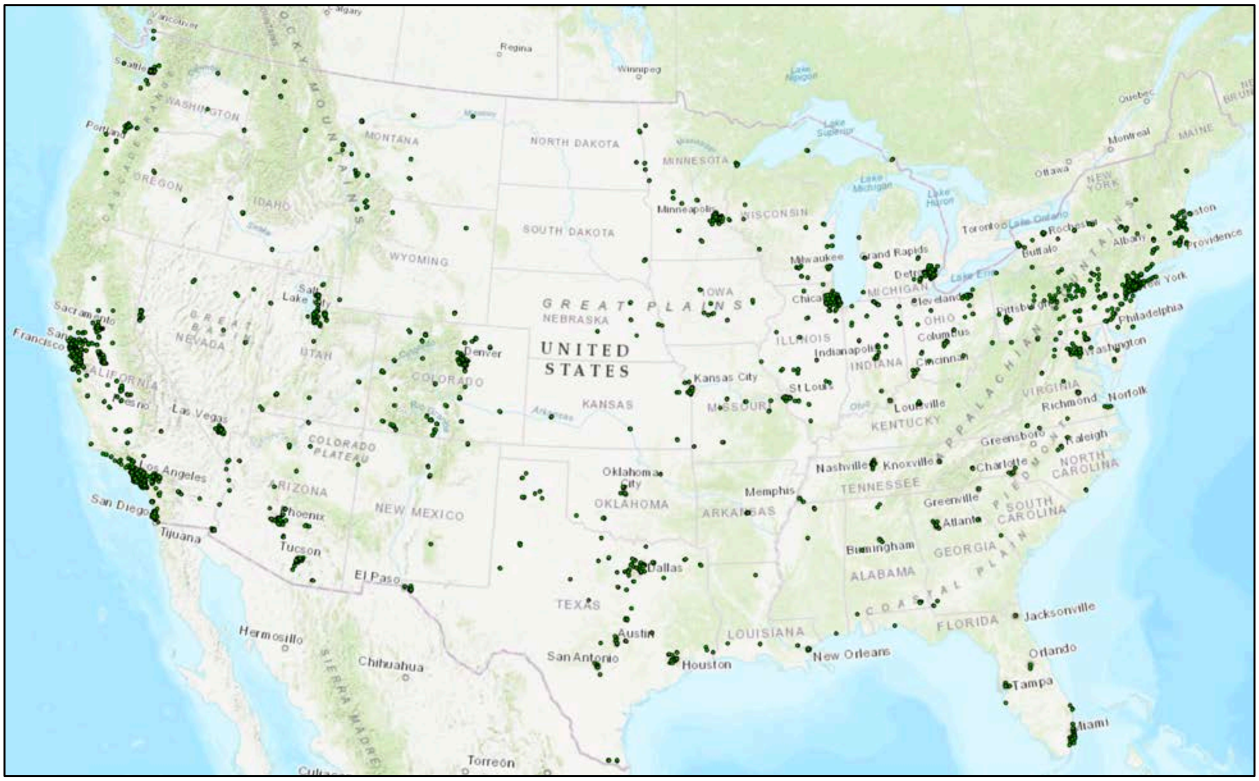
[32] *In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8161 ¶ 432 (2016) ("*Spectrum Frontiers First Order*").

[33] *Id.*; *see also id.* Figure 3 (mapping 70/80 GHz Registered Sites).

the United States.[34] Aeronet has mapped the registered links as of February 2019, included below as Figure 3, demonstrating that the E-Band remains lightly used and that the great majority of links are still concentrated in a few localities.

Figure 3: 70/80 GHz Registered Links



To be sure, terrestrial fixed link usage in the E-Band is expected to increase as 5G services come online, but Aeronet does not anticipate a meaningful risk of interference between its maritime SDDLs and 5G backhaul. 5G backhaul is likely to be located primarily in and around dense population centers. Indeed, commenters in the *Spectrum Frontiers* proceeding who supported mobile use in the E-Band generally did not identify other use cases.[35] And, as explained

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[34] *Id.*

[35] *See In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services,* Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10,988, 11,053 ¶ 198 (2017) ("*Spectrum Frontiers*

above, Aeronet's use case is consistent with locating substantial amounts of its network architecture (fixed ground-based transmitters and receivers) and network activity away from dense urban areas. By so locating its operations, Aeronet can maximize efficient spectrum use across more land mass, and further mitigate any risk of interference with both mobile terrestrial use of the spectrum to support 5G backhaul and Federal FSS operations located at the 28 military bases and the 18 Federal radio astronomy observatories.

Second, the highly directional beams that exist in the E-Band are appropriate for maritime needs, because they support the delivery of targeted bandwidth with propagation losses that ensure very limited signal leakage beyond the intended range.[36] As the Commission previously has described, the E-Band is best suited for systems that "concentrate radiated power in a very narrow path and have considerable attenuation at much shorter distances than occurs in the lower microwave bands."[37] Likewise, the comparatively poor propagation and atmospheric absorption characteristics in the E-Band effectively require providers to utilize high radiated power and directional gain in order to achieve significant range, making the spectrum less well suited for wide area uses. Aeronet's request, discussed in Part III, that the Commission slightly increase the

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Second Order") ("Commenters initially raised considerable doubt about the advisability and desirability of introducing mobile services into the 70/80/90 GHz bands in the near future. . . . In a subsequent *ex parte*, CTIA now supports mobile use of the 70 GHz band [and] . . . Ericsson believes these bands could represent up to 20 percent of all new backhaul deployments as early as 2020.").

[36] *See* Abecassis, Stewart, and Reichl, *supra* note 23, at 2 ("An interesting feature of E-band is that, although located high in the millimetre-wave region of the radio spectrum, where signal absorption levels are high, E-band is located above the oxygen absorption peak occurring at around 60 GHz and hence the usefulness of the band (in terms of the operating ranges that are possible) is more similar to fixed service bands around 30-40 GHz.").

[37] *See In re Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands*, Report and Order, 18 FCC Rcd 23,318, 22,338 ¶ 45 (2003) ("*70/80/90 Band Order*").

transmitter power limitations for SDDLs does not meaningfully change the interference risk analysis; Aeronet's sub-mesh networks will extend to, but not past, ships along their routes.[38]

Third, the large amount of bandwidth in the E-Band is necessary for the delivery of Gbps speeds to support the Internet of the Sea, while minimizing the link budget dedicated for higher modulation schemes.[39] But because this is a new innovative application at the beginning of its efficiency cycle, Aeronet expects to achieve significant improvements both in the short and long term.

Aeronet anticipates sharing spectrum in the E-Band with other new and innovative users, including possible competitors, who share its view that the Band's allocation and service rules should be flexible to permit multiple innovative operations. As explained below, Aeronet's requested modifications are minor and should present minimal concerns for others.

B. Authorizing Maritime SDDLs in the E-Band Is Consistent with the Commission's Regulatory Goals and with International Frameworks.

Since 2003, the Commission has maintained service rules to promote development and use of spectrum in the E-Band, which is allocated to non-Federal and Federal users on a co-primary basis.[40] "Based on [its] determination that highly directional, 'pencil-beam' signal characteristics permit systems in these bands to be engineered so that many operations can co-exist in the same vicinity without causing interference to one another," the Commission has maintained flexible

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[38] Moreover, Aeronet plans to employ automatic power control, which will ensure that the system uses only enough power to close the link, rather than always using the maximum power.

[39] *See* Abecassis, Stewart, and Reichl, *supra* note 23, at 1 ("In general, millimetre-wave bands above 60 GHz have favourable properties for providing high-capacity wireless links, due to the large amounts of spectrum available in these bands (making wide channel widths a possibility, to achieve very-high-capacity links.)").

[40] *See 70/80/90 Band Order*, 18 FCC Rcd 23,318.

allocation and service rules for the 12.9 GHz of spectrum in the E-Band.[41] The rules create a two-pronged authorization scheme for non-Federal entities: First, a putative licensee applies for a non-exclusive nationwide license; second, the licensee registers individual point-to-point links.[42]

In 2014, the Commission identified spectrum in the E-Band, along with other frequency bands above 24 GHz, as potentially being suitable for mobile service.[43] In its subsequent *Spectrum Frontiers* actions, the Commission has made certain spectrum bands available through both licensed and unlicensed mechanisms, but deferred any allocation or service rule changes for the E-Band.[44] Critically, however, the Commission consistently has emphasized the importance of preserving flexibility in the Band to enable innovative new users and uses. For example, when the Commission initially adopted the current rules for the Band, it described that the rules comprised a "flexible and streamlined regulatory framework . . . designed to encourage innovative uses" of the spectrum.[45] In the *Spectrum Frontiers First Order*, the Commission reiterated that its existing flexible and streamlined approach to the E-Band was adopted to encourage innovative uses and to facilitate further development in technology.[46] And, in the *Spectrum Frontiers Second Order*, the Commission again described its decisions regarding the E-Band as "further[ing] the public interest

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[41] *Spectrum Frontiers First Order*, 31 FCC Rcd at 8158 ¶ 424.

[42] Indeed, as noted below, *infra* at 27, the table of "Frequency availability" already notes that E-Band spectrum is allocated for Fixed, Mobile, and Temporary Fixed, but there are not currently service rules for mobile use in the Band.

[43] *See In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Notice of Inquiry, 29 FCC Rcd 13,020, 13,042-44 ¶¶ 75-82 (2014).

[44] *See Spectrum Frontiers First Order*, 31 FCC Rcd at 8160-69 ¶¶ 428-441 (seeking comment on proposals for 70/80/90 allocation and service rules); *see also Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054 ¶¶ 200-201 (deferring action on E-Band rules to separate *Wireless Backhaul* proceeding).

[45] *70/80/90 Band Order*, 18 FCC Rcd at 23,319 ¶ 1.

[46] *Spectrum Frontiers First Order*, 31 FCC Rcd at 8158-59 ¶ 424.

by protecting existing operations and successful services in the 70 GHz and 80 GHz bands without foreclosing future innovations in these bands."[47]

Aeronet's maritime SDDL technology is precisely the type of innovation that the Commission has always invited for the E-Band.[48] And while Aeronet appreciates the Commission's intent to address proposals regarding the allocation and service rules for the E-Band holistically in the *Wireless Backhaul* proceeding,[49] it should act now for two reasons. First, the Commission's decision not to adopt new service and allocation rules for the E-Band in the *Spectrum Frontiers* proceeding was based in part on the lack of "consensus among the proponents" regarding how mobile and fixed operations could coexist, especially in light of the not-yet-fully developed proposals from Aeronet, Loon, the Elefante Group, and others; the Commission thus urged parties to develops the record on "possible methods of promoting coexistence" between innovative and traditional applications.[50] This condition has since been satisfied: There is a robust record that supports prompt action on the E-Band.[51] Second, for the reasons discussed above, time

[47] *Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,056-57 ¶ 207.

[48] The Commission previously has expressed interest in Aeronet's plans for the E-Band, noting that it fits "neither . . . traditional mobile broadband nor fixed link models," while deferring action on certain specific proposals that risked "foreclosing future innovation in these bands." *See Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054, 11,057 ¶¶ 201, 207.

[49] *See In re Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul and Other Uses and to Provide Additional Flexibility to Broadcast Auxiliary Service and Operational Fixed Microwave Licensees*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Second Notice of Inquiry, Order on Reconsideration, and Memorandum Opinion and Order, 27 FCC Rcd 9735 (2012).

[50] *Spectrum Frontiers Second Order*, 32 FCC Rcd at 11,054 ¶¶ 200-201.

[51] *See, e.g.*, *In re Petition to Modify Parts 2 and 101 of the Commission's Rules to Enable Timely Deployment of Fixed Stratospheric-Based Communications Services in the 21.5-23.6, 25.25-27.5, 71-76, and 81-86 GHz Bands*, Elefante Petition for Rulemaking, RM-11809 (filed May 31, 2018); *In re WorldVu Satellites Limited, Petition for Declaratory Ruling Granting Access to the U.S. Market for the OneWeb V-Band System*, Legal Narrative, IBFS File No. SAT-LOI-20170301-00031 (Mar. 1, 2017) ("OneWeb/WorldVu V-band Petition"); *In re WorldVu Satellites Limited*,

is of the essence—both for Aeronet specifically, and for the maritime industry more generally. Furthermore, the amendments that Aeronet is seeking to the Commission's rules are minor and generally consistent with the existing light-license regime.

The Commission's light-touch approach to the E-Band is also mirrored by light-license regimes in the UK, Australia, and other countries.[52] And while other countries have adopted link-by-link coordination, their rules often are functionally equivalent to light-license regulation.[53] If the Commission exercises leadership in this proceeding, there is thus the opportunity for harmonization and replication by other countries, which, in turn, will expand the delivery of at-sea broadband connectivity for global passengers, and lock in U.S. leadership in another critical broadband marketplace.[54]

Amendment to Petition for Declaratory Ruling Granting Access to the U.S. Market for the OneWeb W-band System, Legal Narrative, IBFS File No. SAT-AMD-20180104-00004 (Jan. 4, 2018) ("OneWeb/WorldVu Amendment Legal Narrative"). These proposals are further developed by the commenters and reply commenters in the respective dockets.

[52] *See* Mario Giovanni Luigi Frecassetti et al., *E-Band and V-Band – Survey on Status of Worldwide Regulation* 23 (ETSI White Paper No. 9, June 2015), https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp9_e_band_and_v_band_survey_20150629.pdf; *see also* Abecassis, Stewart, and Reichl, *supra* note 23, at 3 ("It is notable that the majority of the countries surveyed have adopted either self-provided or license-exempt approaches when opening up E-Band for commercial use."); *id.* at 15-32 (summarizing light-license regimes to E-Band in United States and other countries).

[53] *See* Frecassetti, *supra* note 52, at 23.

[54] *See* Abecassis, Stewart, and Reichl, *supra* note 23, at 2 ("A further factor which should favour wider take-up is the flexibility in the use of [the E-Band] that a number of regulators have offered by opening it for use on a self-coordinated . . . basis. The self-coordinated management approach to E-band was originally introduced in the USA and a number of other markets have subsequently adopted similar approaches."); *id.* at 3 ("The fact that regulators around the world are increasingly adopting self-coordinated management approaches in E-band is also a factor that can support the emergence of innovative applications in such bands—as evidenced in the USA, where experimental licen[s]es filed for E-band demonstrate possible new uses that may emerge in [the] future.").

III. The Commission Should Adopt Minor Modifications to the E-Band Allocation and Service Rules to Authorize the Use of Maritime SDDLs.

The Commission can authorize Aeronet's planned use of spectrum in the E-Band to establish maritime SDDLs through minor modifications to the service rules. Indeed, as Aeronet emphasized in the *Spectrum Frontiers* proceeding, the current rules for the E-Band have been largely effective at facilitating private-sector innovation, while causing minimal interference to Federal and non-Federal incumbents. Aeronet thus supports the Commission's maintaining and promoting a light-touch regulatory framework for this spectrum.

The Commission should modify its rules, however, expressly to authorize Maritime Scheduled Dynamic Datalinks as a "fixed service" and "permissible operation" in the E-Band. Specifically, Aeronet requests the following modifications to the Commission's rules:

- 47 C.F.R. § 101.3. As used in this part: . . .
    - *Maritime Scheduled Dynamic Datalink*. A scheduled dynamic datalink serving ships, including a link between a fixed ground station and a ship, between a fixed ground station and a Scheduled Dynamic Datalink Relay, between a Scheduled Dynamic Datalink Relay and a ship, or between two ships.
    - *Scheduled Dynamic Datalink Relay*. An aerostat or drone at a fixed location, below 1,000 feet of elevation, either tethered or untethered, to enable Scheduled Dynamic Datalinks beyond the horizon.
    - *Scheduled Dynamic Datalink*. A point-to-point link between fixed stations and mobile stations, or between mobile stations, where the mobile stations generally follow known routes at known times.
- 47 C.F.R. § 101.113. . . .

Frequency Band (MHz)	Maximum Allowable EIRP[1,2]	
	Fixed[1,2] (dBW)	Mobile (dBW)
…		
71,000-76,000[13]	+ 55	+ 57
81,000-86,000[13]	+ 55	+ 57
. . .		

[13] The maximum transmitter power is limited to 3 watts (5 dBW) unless a proportional reduction in maximum authorized EIRP is required under § 101.115. The maximum transmitter power spectral density is limited to 150 mW per 100 MHz. For Scheduled Dynamic Datalinks, the maximum transmit power is 5 watts (7 dBW) and the maximum power spectral density is 500 mW per 100 MHz.

- 47 C.F.R. § 101.147(a) . . .

(a) . . .

71,000-76,000 MHz (5) (17) (35)

81,000-86,000 MHz (5) (17) (35)

92,000-94,000 MHz (17) (35)

94,100-95,000 MHz (17) (35)

Notes . . .

(35) Scheduled Dynamic Datalinks are permitted in the bands 71,000-76,000 MHz, 81,000-86,000 MHz, 92,000-94000 and 94,100-95,000 MHz bands.

- 47 C.F.R. § 101.1507. Licensees may use the 70 GHz, 80 GHz and 90 GHz bands for any point-to-point, non-broadcast service including Maritime Scheduled Dynamic Datalinks. . . .

Aeronet does not need, and is not requesting, other changes to the current allocation and service rules. The table of "Frequency availability" already notes that E-Band spectrum is available for Fixed, Mobile, and Temporary Fixed, so further changes are unnecessary.[55] The same is true for the Commission's Transmitter power limitations table, which also already includes the maximum allowable EIRP for both "Fixed" and "Mobile" services in the E-Band, although as discussed above, Aeronet is requesting a 2dB increase in the mobile EIRP.[56] Nor is Aeronet requesting any Commission action with respect to the geographic licensing or licensing term of E-Band spectrum.

[55] 47 C.F.R. § 101.101.

[56] 47 C.F.R. § 101.113.

Most importantly, because Aeronet does not anticipate interference concerns or risks, it is not requesting any modifications to the existing *process* for addressing interference between registered datalink holders. Under the current regime, "[t]hird-party database managers maintain a database of all registered links for the purpose of interference protection and establishing first-in-time rights" and are "responsible for coordinating with NTIA through an automated 'green light/yellow light' mechanism to avoid harmful interference to federal operations which share the spectrum."[57] "[W]hen registering a point-to-point link, licensees are required to submit an interference analysis to the database manager that demonstrates that the proposed link will neither cause nor receive harmful interference relatively to previously registered non-federal links"; "[i]f harmful interference does occur, the earliest registered link will have the right to interference-free operation."[58] "If [a] complaining first-in-time licensee is not satisfied that the interference [is] resolved, . . . a complaint may be filed with the Commission."[59] This process is suitable to address interference issues, if any, associated with Aeronet's use of maritime SDDLs.[60]

Aeronet acknowledges that minor modifications to specific link databases may be appropriate. For example, databases likely will need to implement changes to effectively represent

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[57] *In re Spectrum Horizons Battelle Memorial Institute Petition for Rulemaking To Adopt Fixed Service Rules in the 102-109.5 GHZ Band*, Notice of Proposed Rulemaking, 33 FCC Rcd 2438, 2452 ¶ 29 (2018).

[58] *Id.* at 2452-53 ¶ 30.

[59] *In re Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Memorandum Opinion and Order, 20 FCC Rcd 4889, 4896 ¶ 13 (2005).

[60] As Aeronet has previously explained, SDDLs also would be amenable to coordination if the Commission were to adopt its prior proposal to move toward a spectrum allocation model for the E-Band that relied on a Spectrum Access System. *See, e.g.*, Letter from Brian Russell, Chief Operating Officer, Aeronet Global Communications Inc. to Marlene Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177, IB Docket Nos. 15-256 and 97-95, RM-11664, and WT Docket No. 10-112 (July 12, 2017); Letter from Ivor Patrick, Director, Aeronet Global Communications Inc. to Commission's Secretary, Federal Communications Commission, GN Docket No. 14-177 (Sept. 28, 2016).

Aeronet's link registrations as establishing two dimensional polygons and three-dimensional polyhedrons for ground-to-ship and ground-to-relay-to-ship, and ship-to-ship SDDLs. But, as noted, Aeronet does not need these networks to be exclusive use areas. Instead, Aeronet believes that existing methods will allow coordination between Aeronet's SDDLs and incumbent terrestrial-link uses, as well as innovative new uses.

There is recent Commission precedent holding that, under certain circumstances, a service like SDDLs, involving communications between moving points, should be treated as fixed, rather than mobile. The Commission historically authorized FSS as "communications between satellites in orbit and earth stations in fixed locations. However, as the need for broadband communications to vessels, land vehicles, and aircraft . . . evolved, it . . . bec[a]me clear that Mobile-Satellite Service . . . spectrum was not adequate to meet this need."[61] Thus, in a series of actions in 2005, 2009, and 2012, the Commission authorized certain "[e]arth [s]tations in [m]otion" (collectively "ESIM")—earth stations on vessels, vehicle-mounted earth stations, and earth stations aboard aircraft ("ESAA")—to operate in the FSS spectrum, even though the earth stations were not fixed.[62] The Commission described that an ESAA terminal, for example, "would appear *almost fixed* from the perspective of the [geostationary-orbit] [Geostationary Orbit ("GSO")] FSS space station. . . . Accordingly, transmissions from a GSO FSS space station to an earth station fixed to

[61] *See In re Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed Satellite Service*, Notice of Proposed Rulemaking, 32 FCC Rcd 4239, 4241 ¶ 3 (2017) ("*ESIM NPRM*").

[62] *See id.* at 4240-42 ¶¶ 1, 4-6.

airborne aircraft are not materially different from any other transmission from a GSO FSS space station and would be unlikely to result in interference events to other co-primary services."[63]

In 2017, the Commission proposed further action to reduce regulatory barriers that prevented ESIM operations while still "maintain[ing] those [rules] that ensure that FSS earth stations operating while in motion do not cause more interference than FSS earth stations at fixed locations."[64] In 2018, based on its prior successes, the Commission expanded the FSS spectrum in which ESIM could operate and requested comment on "allowing ESIMs to operate in" still more "frequency bands in which earth stations at fixed locations operating in GSO FSS satellite networks can be blanket-licensed because in this situation operation of earth stations in motion should not introduce a material change to the interference environment created or to the protection required."[65] And more recently, the Commission considered applying the same rules to allow communications between ESIM and non-geostationary orbit satellites in the FSS.[66]

The Commission should take a similar approach here. Aeronet's SDDL networks would function as "almost fixed" from the perspective of other users of the E-Band. While the far and/or near ends of the link would be dynamic, they would still operate in a point-to-point fashion, via connection beams with very narrow widths. Moreover, in the maritime context, the dynamic path

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[63] *In re Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands*, Notice of Proposed Rulemaking and Report and Order, 27 FCC Rcd 16,510, 16,518 ¶ 16 (2012) (emphasis added).

[64] *See ESIM NPRM*, 32 FCC Rcd at 4242 ¶ 7.

[65] *ESIM Order*, ¶ 91.

[66] *See In re Facilitating the Communication of Earth Stations in Motion with Non-Geostationary Orbit Space Stations*, Notice of Proposed Rulemaking, IB Docket No, 18-315, FCC 18-160 (rel. Nov. 16, 2018).

of the near and far ends would follow a known and pre-scheduled route—*i.e.*, a ship route. These characteristics mean the service can be considered as a forecasted series of fixed point-to-point broadband links: The location of any given node at any given moment would be knowable in advance and known in real time.[67]

[67] Moreover, like ESIM, Aeronet's maritime SDDLs are an innovative technology that will facilitate connectivity in the highly challenging environment of air travel. *See ESIM Order*, at 77 (Statement of Chairman Ajit Pai) (emphasizing importance of establishing "on-the-road connectivity" to "ships, vehicles, and aircraft—basically any non-stationary platform, especially those that can't be served using other communications technologies"). As noted above, Aeronet has no plans to maintain connectivity when aircraft leave a flight path and thereby exit 3D cone or polygon SDDL sub-mesh networks.

CONCLUSION

This Petition affords the Commission the opportunity to support competition in an underpenetrated market, while fostering the development of an innovative technology and further commercializing relatively greenfield spectrum. Maritime broadband has failed to keep pace with demand, depriving consumers, shiplines, crew, and public safety officials of myriad innovative applications and uses that are in the public interest. Aeronet has demonstrated the ability to deliver Gbps, low-latency connectivity to commercial cruises, ferries, and other ships using scheduled dynamic datalinks in the E-Band. And Aeronet is in a prime position to expand this service to shiplines, third-party service providers, and other partners in the Caribbean, from the United States and abroad. The Commission should act promptly to expressly authorize this use of spectrum in its allocation and service rules for the E-Band by implementing the minor amendments identified herein. By doing so, the Commission will ensure that the United States is the world leader in a new broadband market with a substantial, untapped demand.

Respectfully submitted,

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